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News Briefs

General Developments

Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Building 820, Room 126, Gaithersburg, MD 20899-0001; telephone: 301/975-3577.

IMPLEMENTATION DELAY, REPORT TO CONGRESS ANNOUNCED FOR FQA

NIST announced in the Oct. 7, 1998, *Federal Register* that the Secretary of Commerce will prepare a report for Congress on the Fastener Quality Act of 1990. The report, which must be submitted by Feb. 1, 1999, will address: (1) changes in fastener manufacturing processes that have occurred since the enactment of the FQA; (2) a comparison of the FQA to other regulatory programs that regulate the various categories of fasteners, and an analysis of any duplication that exists among programs; and (3) any changes in the FQA that may be warranted.

The agency previously announced in the Sept. 28, 1998, *Federal Register* that the implementation date of regulations requiring fastener manufacturers to submit their fasteners for testing by laboratories accredited by various accreditation organizations will be extended until June 1, 1999. This follows passage of Public Law 105-234 (signed by President Clinton on Aug. 14, 1998) amending the Fastener Quality Act of 1990.

NIST continues to offer strictly voluntary accreditation to qualified fastener testing laboratories as well as allow voluntary compliance with other provisions of the regulations.

NIST will post updates on FQA developments periodically on the World Wide Web at http://www.nist.gov/fqa. Interested persons also may contact Subhas Malghan, (301) 975-5120, subhas.malghan@nist.gov.
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PACT TO ENHANCE FOREIGN SALES OF U.S. INFO TECH SECURITY PRODUCTS

Five nations made history on Oct. 5, 1998, with the signing of the Common Criteria Mutual Recognition Arrangement, a pact that establishes a precise but common language specifying security requirements in information technology (IT) products and systems. This development is expected to make it easier for American companies to sell their products abroad.

"We see this as a critical step toward resolving the issues that could potentially cripple the growth of domestic and international electronic commerce," said Commerce Deputy Secretary Robert L. Mallett.

The signing culminates 5 years of work by NIST, the National Security Agency, and their computer security/standards counterparts in Canada, France, Germany, and the United Kingdom. The signatory nations agree to recognize the results of security evaluations conducted by each other's accredited testing laboratories. This eliminates the need for costly and time-consuming duplicative testing by different countries.

Once the arrangement leads to a standardized evaluation process across borders, its creators hope that it will foster a barrier-free, worldwide market for IT security products.

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NEW NIST-ANSI AGREEMENT TARGETS CONFORMITY ASSESSMENT ISSUES

With the aim of advancing national industrial, consumer and environmental interests, NIST and the American National Standards Institute (ANSI)—a federation of more than 1300 organizations—have pledged to help boost U.S. participation in international decisions on

standards and conformity assessment issues, which play an increasingly significant role in world trade.

The commitment to "enhance and strengthen" the nation's voluntary standards system was formalized in a memorandum of understanding (MOU) signed by NIST Director Raymond Kammer and ANSI President Sergio Mazza. The signing took place on Sept. 23, 1998, following a national meeting to discuss options for developing a "national standards strategy." Representing companies, government agencies and U.S.-based standards developing organizations—or SDOs—the more than 300 participants generally agreed on the need for a more coordinated U.S. approach to international standards setting. Without it, many said, U.S. industrial and economic competitiveness will suffer.

Building on an earlier NIST-ANSI agreement, the new MOU affirms ANSI's role as the U.S. representative to the International Organization for Standardization and the International Electrotechnical Commission. It further recognizes ANSI's role in accrediting U.S. SDOs as competent to develop consensus standards. Finally, NIST and ANSI agreed to help foster more effective public and private-sector responses to conformity assessment issues.

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NEW MARINE RESEARCH LAB HAS NIST CONNECTION

A new environmental lab in Charleston, S.C., will allow NIST to expand its efforts in quality assurance for monitoring and assessment of the U.S. coastal marine environment. Ground-breaking ceremonies for the Marine Environmental Health Research Laboratory (MEHRL), were held Oct. 10, 1998. Construction of the 7250 square meter facility will begin early in 1999 and is expected to be completed in 2000.

MEHRL will be a joint research center of the South Carolina Department of Natural Resources, the Medical University of South Carolina, the College of Charleston and two agencies within the Department of Commerce (DOC)—the National Oceanic and Atmospheric Administration (NOAA) and NIST.

Appropriations of $19.7 million to fund the MEHRL have been provided by DOC. NOAA and NIST, who have collaborated since 1985 on quality assurance for marine environmental samples, are cooperating in the development of the MEHRL.

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NIST, NCWM SOLIDIFY 93-YEAR-OLD PARTNERSHIP

A newly signed memorandum of understanding (MOU) between NIST and the National Conference on Weights and Measures (NCWM) will make the jobs of state weights and measures inspectors easier in the coming months. Among other things, the MOU paves the way to posting all Certificates of Conformance issued under the National Type Evaluation Program (NTEP) on the Internet. States require NTEP certificates for weighing and measuring devices used in trade. The availability of the certificates on the World Wide Web should boost efficiency during inspections.

The new memorandum leads off a series of pacts to implement an earlier agreement—the first ever—between NIST and NCWM. This agreement, signed in July 1998 at the NCWM annual meeting, seeks to preserve and formalize the historical cooperation between NIST and NCWM. The two have worked together since 1905.

Since January 1998, NTEP has been posting all new NTEP Certificates of Conformance on the World Wide Web at http://www.nist.gov/ntep. In the coming months, NTEP will be adding all certificates issued prior to January 1998 as well as the ability to search for certificate information.

For more information on the NIST OWM or the NCWM, call (301) 975-4004 or visit the website at http://www.nist.gov/owm.

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MORE Y2K HELP AVAILABLE FOR SMALL MANUFACTURERS

Efforts to help small manufacturers in rural America find and assess problems caused by the year 2000 computer problem (referred to as Y2K) have been stepped up through an agreement signed last week by the U.S. Departments of Commerce and Agriculture. The memorandum of understanding outlines a variety of ways that the NIST Manufacturing Extension Partnership (MEP) and USDA can help small manufacturers address the Y2K problem and improve their productivity and competitiveness, especially in the food, fiber, and wood products industries. The agreement was signed as part of National Y2K Action Week, Oct. 19-23, 1998.

Also, MEP debuted its expanded Y2K web site (http://www.mep.nist.gov/hottopics/). In addition to new resources, the expansion provides additional support for small manufacturers using MEP's computer-based system, Conversion 2000: Y2K Self-Help Tool. The tool helps smaller manufacturers conduct an inventory of equipment, identify core business

systems, develop contingency plans and coordinate remediation projects.

For assistance with Y2K conversion, as well as other business and technical assistance, small manufacturers can call 1-800-MEP-4MFG (637-4634) to reach the MEP center serving their region.

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NIST, TWO UNIVERSITIES TO MANAGE PROTEIN DATA BANK

The Research Collaboratory for Structural Bioinformatics (RCSB), a consortium composed of NIST and two universities, has received a $10 million, 5 year award from the National Science Foundation, the Department of Energy and the National Institutes of Health. The award will enable the consortium to operate and significantly extend the capabilities of the Protein Data Bank, a critical tool for unlocking the secrets of biological systems in pharmaceutical and medical research.

The RCSB's Protein Data Bank (PDB), in addition to being a repository of data, now will provide mechanisms for researchers to understand biological function through investigation of sequence and molecular structure. Previously maintained by Brookhaven National Laboratory, the PDB's change in management will be transparent and seamless as it moves to the RCSB with the addition of new capabilities for searching and for improving the consistency and content of existing and future depositions.

The transfer of the PDB from Brookhaven to the RCSB will result in several improvements, including faster access; a greater number of query capabilities, including more complex and more accurate queries; a uniform archive; a dynamic cross-link to other databases; and the availability of structure validation and structure and sequence neighboring.

The PDB data will be stored and mirrored at all three RCSB sites. The PDB also will be mirrored at key sites worldwide. The PDB is accessible from the World Wide Web at http://www.rcsb.org.

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NIST INVESTIGATION REPORT AVAILABLE AS CASE STUDY

On April 21, 1995, the contents of a large blender reacted and exploded at a chemical plant in Lodi, NJ. Five employees were killed, another four were injured and 300 people in nearby homes and businesses had to be evacuated. The Occupational Safety and Health Administration (OSHA) asked NIST to evaluate the accident to see if there was metallurgical or mechanical failure. The conclusions reached at the time were included in the Chemical Accident Investigation Report prepared by OSHA and the Environmental Protection Agency (EPA).

A more comprehensive description of the NIST metallurgical investigation—for use as a case study in failure analysis—has just been published. The report marks the first time that NIST has exclusively detailed its role.

Why did the explosion occur? The NIST researchers ruled out a metal failure because "the stainless steel shell of the blender was structurally sound and had very little damage. [NIST] found no evidence that the shell was breached prior to the accident or that the chemical reactions initiated at the surface of the shell."

OSHA and EPA determined that the explosion was most likely caused by a small amount of water getting into the chemicals being processed. At the time of the accident, the blender was being used to mix aluminum powder, sodium hydrosulfite, potassium carbonate and benzaldehyde for use as a gold precipitating agent. One possible entry point for the water was a worn seal found during the investigation.

For a copy of the metallurgical investigation report, contact Sarabeth Harris, MS 104, NIST, Boulder, CO 80303-3337, (303) 497-3237, sarabeth@boulder.nist.gov. Ask for paper no. 33-98.

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NEW CAPACITANCE STANDARD MAY IMPROVE CALIBRATION SERVICE

NIST researchers have developed and operated a new type of capacitance standard with a relative uncertainty of less than 10^{-6}. The standard brings together for the first time two technologies developed at NIST.

The first technology is an electron pump, based on ultra-small tunnel junctions and operating at temperatures less than 0.1 K (–273.05 °C or –459.49 °F), which passes and counts individual electrons with a relative uncertainty of 10^{-8}. The second technology is a cryogenic, vacuum-gap capacitor that has exceptionally low leakage and frequency dependence because it does not contain the dielectric materials that make ordinary capacitors imperfect.

After the pump places about 10^8 electrons on the capacitor, the resulting voltage across the capacitor is measured, and the capacitance is the ratio of pumped charge to measured voltage. When compared with the best commercial capacitance meter, the standard shows agreement well within the 2×10^{-6} relative uncertainty

of the commercial instrument. With improvements to room temperature electronics, the new standard should reach a relative uncertainty of 10^{-7}.

An investigation of possible systematic effects will be done by comparing the new standard with NIST's calculable capacitor, which is the fundamental standard for capacitance in the SI system of units. If the new standard performs over a range of frequencies with a relative uncertainty of 10^{-7}, as expected, it could offer significant improvement in NIST's calibration service for capacitance.

In addition, the new standard continues a trend in metrology of basing standards on properties of nature, in this case the quantization of charge, rather than physical artifacts. Natural or quantum standards are easier to replicate than artifacts and thus allow improved consistency of measurements at standards labs worldwide.

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NIST-DEVELOPED, INTERNET-BASED AEGIS SPY RADAR COOLANT CONTROL DEMONSTRATION SYSTEM DEPLOYED ON USS *SULLIVAN*

Two NIST scientists integrated the NIST-developed, Internet-based Aegis Spy Radar Coolant Control Demonstration software and hardware into a portable unit. One of the scientists participated in the installation, testing, and integration of the unit with the wireless LAN system onboard the USS *Sullivan* (DDG-68), a U.S. Navy Aegis class destroyer docked in Mayport, FL. During the installation, integration and testing, the scientist worked with engineers from the private company that had installed the 32-node wireless LAN network in the USS *Sullivan*.

The other NIST scientist held a training session for the engineers who would be responsible for installing the NIST demonstration software environment onto the *Sullivan*. The session provided the engineers with hands-on training on how to install, set up, modify, and deploy the requisite software and updated site files to the onboard system. This provided the engineers with the capability to mirror the NIST site installation onboard the Aegis destroyer for their wireless testing and deployment of IEEE 1451-based transducers. IEEE 1451 is an emerging standards for networking smart transducers.

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MEL DEVELOPS ITU H.323-BASED PROTOTYPE MULTIMEDIA CONFERENCING SYSTEM

A NIST scientist has researched, designed, acquired, and implemented all facets of an ITU (International Telecommunications Union) H.323 standards-based multimedia conferencing prototype system.

The ITU, headquartered in Geneva, Switzerland (http://www.itu.ch), is the international organization that organizes, develops, regulates, and standardizes global telecommunications. The H.323 standards-based architecture was developed by member nations of the ITU as an umbrella standard for multimedia conferencing. This architecture includes a variety of standards for real-time audio, video, data collaboration/sharing, and conferencing.

The ITU H.323-based prototype developed at NIST stems from an Organization of American States (OAS) initiative to provide electrical measurement services to North America. The system provides multiple clients with the ability to share Internet-based audio, video, data, and applications collaboratively in both low and high bandwidth situations.

The OAS H.323 conferencing system was recently demonstrated to NIST officials and Department of Energy officials of the Sandia National Laboratories, who are very interested in how NIST accomplished this program technically and who would like to build this type of system at Sandia and at Lawrence Livermore National Labs as well.

Future plans for the NIST system include using the prototype in the study of Internet-based calibration services.

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NIST NETWORK EMULATION TOOL (NIST NET) GAINS WIDE INDUSTRY USE

Since its public release by NIST in January 1998, well over 300 users and institutions worldwide have acquired NIST Net and are using the tool for a variety of advanced research and development purposes. Uses of the tool include the testing of voice over Internet protocol (IP) technology, design of mobility protocols,

IP/Asynchronous Transfer Mode (ATM) Quality of Service research, network benchmarking, congestion control research, development of Internet games, routing protocol research, evaluation of collaborative environments, testing of distributed medical applications, xDSL and cable modem performance emulation, design of network management applications, testing fault tolerance of video conferencing systems, testing of collaborative Virtual Reality Modeling Language environments, and evaluation of web server performance dynamics. NIST Net also is being used by several universities for instructional purposes.

NIST Net is a general-purpose tool for emulating performance dynamics in IP networks. The tool was designed to allow controlled, reproducible experiments with network performance sensitive applications and control protocols in a simple laboratory setting. By operating at the IP level, NIST Net can emulate the critical end-to-end performance characteristics created by various wide area network situations (e.g., congestion-dependent packet loss) or by various underlying subnetwork technologies (e.g., asymmetric bandwidth situations of xDSL and cable modems).

NIST Net is implemented as a kernel module and set of extensions to the Linux operating system and is controlled through an X Window System-based user interface application. In use, the tool allows an inexpensive PC-based router to emulate numerous complex performance scenarios, including packet loss distributions, congestion loss, bandwidth limitations, and packet reordering/duplication. The X Window interface allows the user to select specific traffic streams passing through the router and to apply selected performance "effects" to the IP packets of the stream. In addition to the interactive interface, NIST Net can be driven by traces produced from measurements of actual network conditions, in order to reproduce these in the laboratory. NIST Net also provides support for user-defined packet handlers to be added to the system. Examples of the use of such packet handlers include time stamping/data collection, interception and diversion of selected flows, or generation of protocol responses from emulated clients.

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NIST SCIENTISTS TEAM WITH NRL TO MEASURE SOLAR CONSTANT FROM SPACE

NIST scientists recently participated in the NASA-sponsored Phase B study of the total solar irradiance monitor (TSIM) satellite project. The TSIM satellite, scheduled for launch in 2001, will make accurate measurements of the solar constant (total solar power reaching a given area of the Earth) above the Earth's atmosphere (600 km altitude).

The perhaps inappropriately named solar constant—more accurately referred to as the exo-atmospheric solar irradiance—appears to exhibit variability on the order of 0.1 % over the past two decades of satellite measurement. This variability may be a major contributor to climate changes. However, existing solar irradiance measurements have rather large uncertainties. The NIST scientists are joining with the scientists from the Naval Research Laboratory (NRL) to produce an instrument to make the most accurate measurement of solar irradiance yet and to better monitor the short-term variability in the solar constant.

The NRL/NIST team's instrument on the TSIM satellite, called the total and spectral solar irradiance investigation (TASSII), utilizes the latest technology for absolute radiometric measurements developed by the NIST scientists. The TASSII instrument will be calibrated directly against NIST radiometric standards to optimize the accuracy of the solar irradiance measurement. The experiment represents the first use of a NIST absolute radiometer to measure the solar constant from space.

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ABSOLUTE RADIOMETER BASED ON HIGH-T_C SUPERCONDUCTORS

NIST scientists have constructed and tested a new absolute electrical substitution radiometer (ESR) that makes accurate measurements at liquid nitrogen temperatures. ESRs have been used for several years at liquid helium temperatures by national metrology institutions for the highest accuracy measurement of optical power and realization of radiometric scales. The new high-critical-temperature active cavity radiometer (High-T_c ACR) uses extremely sensitive temperature sensors made from a thin film, high-T_c superconductor operating at liquid nitrogen temperatures, making measurements much more convenient to carry out and with only a modest degradation in accuracy.

By operating the sensors on the resistive edge of the superconducting phase transition near 90 K, unprecedented sensitivity for an ESR at these temperatures was achieved. For example, an absolute flux measurement of 10 μW can be made with a noise-limited 1 standard deviation relative uncertainty below 0.2 %. While this uncertainty is significantly larger than the uncertainty of optimized liquid helium cooled ESRs, it is sufficient for a wide range of calibration and measurement

applications that benefit from easier, cheaper ways of making accurate optical power measurements.
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NIST HALF-LIFE MEASUREMENT SHEDS LIGHT ON CALCIUM PRODUCTION IN SUPERNOVA CASSIOPEIA A

NIST scientists recently measured the half-life of ^{44}Ti with unprecedented accuracy, providing clues to production of heavy elements in supernova explosions. Researchers used 20 years worth of NIST measurements of a ^{44}Ti source, determining the half-life to be (60.7±1.2) years, compared with previously reported measurements ranging from 39 years to 66 years. Accurate measurement of decay constants generally requires observation of decay for periods comprising a significant portion of a half-life, and only NIST has maintained accurate measurements of the activity of a single ^{44}Ti source for such an extended time.

Most of the heavier elements found in nature are products of supernova explosions, including ^{44}Ti. This isotope decays slowly to ^{44}Sc, which then decays rapidly to the stable isotope ^{44}Ca, a component of natural calcium plentiful on the earth and critical to life. It is believed that all existing natural ^{44}Ca was generated from supernovae through this decay chain.

The ^{44}Ti-^{44}Sc-^{44}Ca decay process releases a characteristic cascade of gamma rays, including one with an energy of 1157 keV that can be observed in the glow of recent supernovae. The COMPTEL and OSSE gamma-ray telescopes on the orbiting Compton Gamma Ray Observatory have measured the flux of 1157 keV gamma rays from the supernova remnant Cassiopeia A, which exploded (as seen from Earth) about 1680 AD. From the known distance to Cassiopeia A (about 1014 km from Earth), the time since the explosion, and the current gamma ray activity, the amount of ^{44}Ti produced in the supernova can be calculated if the ^{44}Ti half-life is accurately known. The ^{44}Ti abundance is an important test of numerical models of the complicated supernova dynamics. The ^{44}Ti half-life had been a large source of uncertainty in this calculation.

In typical half-life measurements, the radioactivity of a source is measured over a time long enough to reveal the exponential decay in its activity. This procedure is difficult when the half-life is long. Many measurements of the ^{44}Ti half-life were reported between 1965 and 1996 ranging from 39 years to 66 years. The recent NIST measurement capitalized on 20 years of carefully calibrated measurements of the radioactivity of a ^{44}Ti source produced in 1978. (These data were recorded to calibrate gamma-ray detectors for the Standard Reference Material radioactive source program.) Because the NIST measurements were collected over a time period comparable to the half-life, the determination was free from many systematic problems that affected previous experiments made over much shorter time periods.
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NIST CONTRIBUTES TO ASTM STANDARDS FOR AGING NUCLEAR POWER PLANTS

NIST scientists have been instrumental in creating, updating, and maintaining important standards dealing with aging of nuclear power plant reactor pressure vessels due to the effects of neutrons. During the operational lifetime of nuclear power plants, fast-neutron irradiation of reactor pressure vessels (RPV) will degrade certain mechanical properties important to maintaining structural integrity. Specifically, fast-neutron-induced embrittlement brings about a reduction in the fracture toughness of the RPV steel that potentially could lead to a catastrophic loss of coolant accident.

The accumulated neutron fluence defines the service life of nuclear power plants. Changes in fracture toughness brought about by neutron irradiation are a complex function of several factors, the most important being the fast-neutron fluence. Because of the obvious safety implications, neutron metrology standards that prescribe the accepted means of determining fast-neutron fluence have been created by the American Society for Testing and Materials (ASTM) Subcommittee E 10 on Nuclear Radiation Metrology. NIST scientists have played a leading role in setting and updating these standards, specifically designed to help ensure the structural integrity of reactor pressure vessels.

The first generation of U.S. nuclear power plants is reaching the end of the original 30 year design life. Power plants can continue to operate if recertified, which depends critically on determining the degree of reactor vessel neutron embrittlement. With nuclear plants providing about 20 % of U.S. electric power, and no new U.S. plants scheduled for construction, it is vital both economically and for nuclear safety that accurate assessment of reactor vessel condition be made.
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NIST CONTRIBUTES TO ASTM VOLUNTARY STANDARDS FOR STERILIZATION OF MEDICAL PRODUCTS

NIST scientists were the primary authors of the American Society for Testing and Materials (ASTM) alanine radiation dosimetry standard. This standard is recognized widely as the best for high-dose measurements in the radiation processing industry. It currently is used by NIST and all major national metrology institutions for calibrating industrial sources. The traceability to national standards and improved accuracy realized through the industrial application of the ASTM alanine standard assures the quality of domestic products and facilitates foreign sales of U.S. products. NIST scientists served on the ASTM Subcommittee E10 on Nuclear Technology and Applications as task group chairs and advisors to lead creation of the new alanine dosimetry standard.

More than 200 industrial ionizing radiation sources are currently operating throughout the world generating tens of billions of dollars in annual sales, with approximately one-third of the sources in North America. As the industry expands, U.S. businesses are facing intense foreign competition, particularly in medical products (including syringes, surgical sutures and utensils, implanted materials, and tissues), pharmaceutical sterilization, food irradiation, curing of materials and coatings, and the treatment of municipal and industrial wastes.

Irradiation represents about 50 % of the market share for product sterilization, nearly double the 1990 share. In some radiation processes, especially those impacting public health and safety, the release of irradiated product for public use depends on dosimetry measurements proving that the required treatment has been achieved. Thus, it is important and often required that dosimetry in radiation processing be suitably accurate and traceable to a primary standard.

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NIST CONTRIBUTES TO ANSI VOLUNTARY STANDARDS FOR TRACEABILITY OF RADIOCHEMICAL MEASUREMENTS AND STANDARDS

Over the past several years, NIST scientists have been working with the American National Standards Institutes (ANSI) nuclear instrumentation N42 and N13 committees to establish widely accepted criteria for radioanalytical traceability. Three standards have been published: (1) ANSI N42.23 (Measurement and Associated Instrumentation Quality Assurance for Radioassay Laboratories), (2) ANSI N42.22 (Traceability of Radioactive Sources to the National Institute of Standards and Technology and Associated Instrument Quality Control), and (3) ANSI N13.30 (Performance Criteria for Radiobioassay). Each of these standards was developed through consensus participation among industrial, commercial, utility, federal, state, and national laboratory representatives to strengthen the credibility of national radioanalytical programs.

ANSI N42.23 envisions the accreditation of a small group of program-specific reference laboratories that participate directly in a traceability-testing program with NIST, technical document reviews, and on-site assessments. These reference laboratories would act as intermediaries in the establishment of the traceability testing link to the service laboratories through performance testing (PT) programs. One current driving force to establish reference laboratories is the privatization of the EPA Drinking Water Crosscheck Program that will require the NIST National Voluntary Laboratory Accreditation Program (NVLAP) accreditation of PT providers for drinking water laboratories. The traceability testing criteria for radiobioassay PT reference laboratories defined by ANSI N13.30 are similar. A third sector that will be establishing traceability testing for its reference laboratories is the Department of Energy (DOE) for its environmental remediation work.

The ANSI N42.22 standard provides additional and more specific criteria for source manufacturers, including those reference laboratories that will be producing PT materials. In addition to the criteria for quality assurance, facilities and equipment, and certificates, ANSI N42.22 provides very specific criteria for the acceptance of testing results.

It is anticipated that traceability testing for the reference laboratories supporting these four national sectors will be initiated by the end of 1999.

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HIGH-FLUX NEUTRON BACKSCATTERING SPECTROMETER IS THE HIGHEST INTENSITY SPECTROMETER OF ITS KIND IN THE WORLD

NIST scientists have recently completed initial performance tests of the new high-flux backscattering spectrometer (HFBS) at the NIST Center for Neutron Research. These tests show that the HFBS has exceeded its target for neutron beam flux by 40 %, making it the highest intensity spectrometer of its kind in the world. In addition, the HFBS met its two other primary goals of delivering an instrumental energy resolution of less than 10^{-6} eV (a measure of the minimum change in neutron energy the HFBS can resolve), and a dynamic

range of $\pm$ 60 $\times$ 10^{-6} eV (the range over which the average neutron energy can be varied). The design of the HFBS incorporates several novel devices that help to boost the neutron intensity incident on the sample, thereby greatly extending its measurement capabilities beyond those of existing backscattering spectrometers.

Neutron scattering spectroscopy is uniquely suited to investigate many types of dynamical processes in solids and liquids. The HFBS will be used to conduct studies of a wide variety of important physical phenomenon that take place on time scales ranging from 5 $\times$ 10^{-7} s to 10^{-10} s. Examples of such phenomena include the diffusion of atoms and ions in materials such as those important for fuel cells and batteries; the reorientational and tunneling motions of molecular species in, for example, catalysts and molecular sieves; and the dynamics of macromolecular materials, including biological systems. The HFBS also will be used to perform kinetic studies that could lead to a greater understanding of the method by which cement cures.

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NIST ENSURES RELIABILITY OF WINDOWS FOR SPACE APPLICATIONS

Responding to requests from both government and industry NIST scientists are assisting in the certification of window glasses for use in the space shuttle and the international space station. The reliability of brittle materials like glass depends on the distribution of surface defects as well as exposure to moisture, which causes small defects to grow over time. To determine the reliability of space application glasses, NIST scientists designed experiments and developed measurement and analytical techniques for quantifying the subcritical crack growth behavior of fused silica glass, a replacement for the glass currently used as well as sodium aluminosilicate glass. In addition, reliability assessment methodologies for the use of this data in lifetime predictions have been developed.

Crack growth behavior was quantified not only with large cracks in fracture mechanics specimens but also with the small, intrinsic cracks that exist in actual windows using static loading (static fatigue) and constant loading rate (dynamic fatigue) test techniques. Failure times under static load conditions ranged from tens of seconds to more than 2000 h. A stress corrosion limit or fatigue limit was observed in the sodium aluminosilicate glass, while no fatigue limit was observed in fused silica. Several new techniques were developed to analyze the resulting data. Of particular note are techniques to determine intrinsic subcritical crack growth parameters from the distribution of failure times under static loading and an analysis to determine crack growth parameters with confidence intervals for subcritical crack growth from dynamic fatigue experiments.

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ASYMMETRY IN GEOMETRY OF MAGNETIC DOMAIN SPREADING OBSERVED IN EXCHANGE-BIASED NiO/NiFe BILAYERS

For the first time, the remagnetization process in an epitaxial exchange-biased antiferromagnet/ferromagnet (NiO/NiFe) bilayer has been observed. Such bilayers are essential features of magnetic devices like giant magnetoresistance read heads, which are used with all of the new very high storage capacity hard discs. Understanding the remagnetization process is of extreme importance to the design and operation of such devices.

Using the magneto-optical imaging film technique (MOIF) developed at NIST for imaging magnetic domains with optical resolution, NIST scientists were able to image the domain pattern in the above bilayer and to observe the dynamics of the magnetization reversal process.

In the MOIF technique, a transparent Bi-substituted iron garnet indicator film is placed on top of the sample and polarized light is passed through the indicator film and reflected by an Al underlayer. Due to the magneto-optic Faraday effect, the polarization of the reflected light is changed by the normal component of the magnetic stray field of the sample, and this is detected by brightness contrast in a polarizing microscope. Hence, magnetic domain walls are observable and directions of magnetization within the domains are determinable from the contrast variations. The above NiO/NiFe bilayers [grown on (001) MgO] have a magnetic anisotropy defined by an exchange bias direction. It was observed that remagnetization along the bias axis, but opposite the exchange bias direction, initiated at the sample edge and propagated into the interior of the sample. However, for remagnetization back to the bias direction, the reversal of domains started at crystal defects in the interior of the sample and spread from them to cover the surface. Previously, the geometry of domain spreading had been assumed to be symmetrical due to the symmetric shape of most hysteresis loops. The observed asymmetry in the geometry of domain spreading was repeatable over many cycles and helps explain why the hysteresis loops for such exchange biased bilayers, although symmetric in shape, are displaced along the field axis. No such asymmetry in the remagnetization mechanism is observed in thin NiFe

films grown directly on (001) MgO with no NiO layer. The asymmetry in the NiO/NiFe bilayer is due to local variation in the energy barrier to domain nucleation caused by the local spin arrangements in the NiO antiferromagnet. These spin arrangements are different for the different saturation states due to the unidirectional exchange bias between the NiO antiferromagnet and the NiFe ferromagnet. This finding is of utmost importance for assessing the magnetic field response of such a bilayer.

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NEW WEAR MACHINE DEVELOPED

NIST cooperative research with four private companies recently culminated in the successful development of an accelerated-wear-test machine. Based on this achievement, the companies now are planning to extend their cooperative research and development agreements with NIST for another 2 years.

To generate improved products, companies need to be able to acquire information rapidly on the phenomena and basic processes involved in the long-term wear of new materials, particularly ceramics and ultrahigh molecular weight polyethylenes, under a variety of loading and cyclic conditions. The design objective was to develop a machine that could accelerate wear without compromising the basic wear mechanisms that take place in the human body.

NIST scientists, working with an engineer from a local university, have developed a new test machine that meets these needs. The machine can evaluate a diverse combination of materials, including those involved in either artificial hip or knee joints. The simulated wear rates correctly ranked materials, for which test information was available from other sources. In addition, wear debris particles and changes in surface texture, caused by the accelerated wear also were similar to those seen from the wear of actual implants in the body. With the new machine, accelerated screening testing of materials now may be completed in as little as a week, depending on the particular objectives of the test.

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NIST SPONSORS ADVANCED ENCRYPTION STANDARD (AES) CANDIDATE CONFERENCE

In August 1998, NIST sponsored the First AES Candidate Conference to announce the acceptance of 15 sophisticated cryptoalgorithms as candidates for the new encryption standard that NIST is developing as a Federal Information Processing Standard (FIPS) to protect sensitive unclassified information for the next 20 to 30 years. Researchers from 12 different countries worked on developing the formulas unveiled at the conference.

NIST is soliciting comments from industry, academia, standards bodies, and the public during the first evaluation period, which ends April 15, 1999. Comments received in this process will be used to narrow the field of candidate algorithms to five or fewer for a second round of public evaluation. When the AES is selected, NIST expects that the algorithm will provide strong security in protecting sensitive unclassified information well into the next century. More information about the AES is available at http://www.nist.gov/aes.

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NIST TESTS ASSESS ULTRASONIC TECHNOLOGY FOR IMPROVING FLOW MEASUREMENTS

NIST scientists have completed the first of a planned three-phase program to assess ultrasonic technology—especially but not exclusively the clamp-on, travel-time technique—for its potential for improving flow measurements. This rapidly evolving technology has the potential of serving not only as a flow meter and as a valuable flow transfer standard but also, possibly, as a primary standard for flow measurement. NIST has just finished a three-part work phase producing a set of tests of several commercially available clamp-on meters using NISTs flow standards; a set of computational fluid dynamics (CFD)-modeled pipe flows for the test conditions; and a set of computer simulations for the types of meters tested.

The test program was done using water, in 250 mm diameter stainless steel pipe; the flow ranged from 4000 L/min to 28 000 L/min, producing a Reynolds number range from 4×10^5 to 3×10^6. The clamp-on meters, which had been precalibrated by their manufacturers, were installed in ideal conditions and tested to quantify their optimal performance in ideal installation conditions; results showed relative uncertainties of less than 3 % for most of the units tested.

Computer simulation results show that the clamp-on meters should read 5 % to 6 % high in the NIST test conditions when they are set up with the assumption they will be measuring uniform pipe flow. Since test results show that these meters read high by about only one-half of these values, the researchers conclude that the manufacturers are compensating somewhat for actual profile distributions but the compensations need further improvement.

As part of the NIST test arrangement, test results also were produced for an in-line, wetted sensor, ultrasonic flow meter that uses an 8 chordal path arrangement to assess and compensate for nonideal flow profiles. This meter, which had not been precalibrated by the manufacturer but had been simply set up using basic length and time measurements, showed relative uncertainties of 0.2 % or less for most of the flows tested. These results indicate the potential travel-time ultrasonic technology may have for comprising primary flow standards. If such potential is realized, it could help significantly in establishing and monitoring flow measurement traceability for conditions, such as pipe size or flow rate, beyond those attainable in NISTs current facilities.

Successive phases of this program are planned in which meter tests and computer simulations would be done in more practical installations such as downstream of an elbow and downstream of a reducer; these pipeline elements often are found upstream of flow meters in actual practice. The results from these three work phases should contribute to improving written standards to guide industrial practice in using ultrasonic flow meters. These successive phases await collaborative support from U.S. industry.

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NEW FACILITY COMMISSIONED FOR BENCHMARK SPRAY COMBUSTION DATA

NIST researchers have commissioned a new experimental facility that will provide a benchmark experimental database for input and validation of spray combustion models. Control of process efficiency and the formation of species by-products from industrial combustion systems (e.g., power generation and treatment of process liquid chemical wastes) are relying increasingly on computational fluid dynamics simulations to provide relevant process information in a cost-effective manner. However, there is a dearth of reliable statistically significant data for specifying model initial/boundary conditions and a need for experimental/numerical comparative analysis of conditions within the reactor. Benchmark data on the characteristics of the droplet field, flame structure, heat transfer, and particulate/gaseous byproducts, and its interrelationship with the system operating conditions are crucial for the development and calibration of advanced computational models.

The experimental apparatus consists of a burner with a movable vane swirl cascade. The burner is enclosed within a stainless steel chamber to allow for better-controlled operation of the system and reproducibility of the spray flame characteristics. Different fuel injector concepts are under investigation in an effort to develop a reference atomizer that will produce well-controlled size and velocity distributions and provide known initial conditions at the injector inlet. Methanol currently is used as the baseline fuel because its thermochemistry is well understood, with its thermophysical and chemical properties available in the NIST Chemistry WebBook. A variety of diagnostic techniques are being employed to characterize the boundary conditions and multiphase combustion processes within the flow field. Of particular interest are measurements of the spray characteristics, gas phase velocities and temperatures, heat flux, and chemical reaction byproducts. The measurements to be included in this database will evolve ultimately to meet the needs of NIST partners in industry and academia who are modeling multiphase combustion processes.

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DIODE LASER PULSE SYSTEM ACHIEVES RECORD 0.45 ps PULSE WIDTH

A compact benchtop semiconductor laser diode system has been assembled by a NIST scientist, which has been tuned to achieve an optical pulse width (full width half maximum) of approximately 450 fs. This is a significant improvement over previous pulse widths that were in the 5 ps regime. The system generates a pulse train having a 500 MHz repetition rate and an average optical power output of 15 mW at a wavelength of 830 nm. This operation has been observed to remain stable over a period of several days in the lab (25 °C, 40 % relative humidity). The basic system was developed by a private company.

This system is being developed for characterizing the impulse response of 50 GHz bandwidth (BW) sampling oscilloscopes and corresponding parameters of pulse generators having step-like outputs of about 7 ps or faster. There are two U.S. companies that manufacture fast sampling oscilloscopes having effective (3 dB attenuation) BWs of 20 GHz and 50 GHz. At the present time, NIST offers calibration services for fast (17 ps rise time) pulse generators that are used to support the 20 GHz oscilloscopes. Only a foreign laboratory presently has the means for supporting 50 GHz sampling oscilloscopes by using an optoelectronic-based fast electrical impulse generator for determining the impulse response of the oscilloscope. A number of technical hurdles still remain before NIST will be able to offer similar capability, including: (1) the development of a corresponding electrical impulse from the 450 fs optical impulse by means of a very fast photoconductive switch, which can produce a low-aberration, Gaussian-shaped, 1 ps to 2 ps full width, half-maximum impulse; (2) transmitting the electrical impulse through a

50+ GHz 3 dBBW connector without significant waveform degradation; (3) sampling (measuring) this impulse with an [equivalent-time, (75 to 100) GHz 3 dB BW] optoelectronic (or electro-optic) sampler; (4) using this fast electrical impulse to estimate the impulse response of a 50 GHz 3 dB BW sampling scope; and (5) applying a satisfactory (stable, convergent) deconvolution algorithm, employing the impulse response estimate, to the applied waveform samples obtained by the 50 GHz 3 dB BW sampler.
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NIST CONDUCTS FIRST MEASUREMENTS IDENTIFYING IONS IN INDUCTIVELY COUPLED PLASMA REACTORS

The development of new high-density, inductively coupled plasma (ICP) reactors that are gaining widespread use in the semiconductor industry require that measurement techniques be developed and applied to these plasmas. Responding to this need, NIST researchers have modified the mass spectrometer/ion energy analyzer used previously for measurements on capacitively coupled reactors and have applied the instrument to a standard ICP reactor. The bombardment of semiconductor surfaces by energetic ions plays a significant role in the plasma processing of microelectronic devices. A significant amount of work has been performed at NIST in the past to investigate the identities and energies of these ions and the processes by which they are formed and transported to the surface. This work has concentrated on processing plasmas generated in capacitively coupled reactors, which then were the predominant type of reactor used by the industry. NIST contributions from this work were the development of reliable measurement techniques for measuring ion fluxes and energies and the measurement of several benchmark parameters necessary for the validation of models used to describe the reactors. Because of the high levels of ionization and dissociation in the ICP reactors compared to the older reactors, the identity and relative fluxes of the etching ions are unknown, which significantly hinders modeling efforts. This is the area in which the researchers at NIST have concentrated their efforts.

The modified instrument has been used to measure ion fluxes and composition in inductively coupled plasmas in a wide range of industrial gases and mixtures: Ar, N_2, O_2, Cl_2, CF_4, C_2F_6, SF_6, $CF_4/O_2/Ar$, $C_2F_6/O_2/Ar$, SF_6/Ar. The results show that for simple gases (Ar, N_2, O_2) the dominant ion is always the parent ion. However, for industrial gases and mixtures that are more reactive and/or complex, the ion flux is often made up of a variety of fragment ions. For example, in a mixture of $CF_4/O_2/Ar$, a mixture commonly used for plasma cleaning, eight ions are created in the discharge that have fluxes of comparable magnitude. The work done here is the first measurement to identify these ions and is one of the fundamental steps necessary to understand, model, and extend these plasma techniques.
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NIST SP 250-47 DOCUMENTS IMPROVED CAPACITANCE CALIBRATION SERVICE

A new Special Publication, SP 250-47 describes the complete NIST calibration services for capacitance standards at low frequencies (66 Hz, 100 Hz, 400 Hz, 1000 Hz, and 10 kHz). Discussed is the process of transferring the unit of capacitance from the NIST primary capacitance laboratory, which maintains the U.S. representation of the farad (realized by the NIST calculable capacitor), to the NIST impedance calibration laboratory as well as the measurement procedures used to calibrate high-accuracy capacitance standards with nominal values in the range of 0.001 pF to 1 μF. Also explained are the quality controls for the reference standards and check standards used in the impedance calibration laboratory.

As a consequence, the uncertainty for calibrating state-of-the-art, fused-silica type capacitance standards has been improved. Routine calibrations for such standards now can be made with a relative uncertainty (the expanded standard uncertainty using a coverage factor, $k = 2$) of only 1.7×10^{-6}.
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TWO NEW PRECISION MEASUREMENT GRANTS AWARDED

Two new $50 000 NIST Precision Measurement Grants have been awarded for fiscal year 1999. The recipients, David E. Pritchard of the Massachusetts Institute of Technology and Suzanne T. Staggs of Princeton University, were selected from a group of 27 candidates. NIST sponsors the grants to promote fundamental research in measurement science in U.S. colleges and universities and to foster contacts between NIST scientists and academic scientists actively engaged in metrology research.

The aim of Pritchard's project, "Accurate Atomic Mass Measurements," is to reduce significantly the uncertainty of the measured values of the relative atomic masses of a number of atoms for a variety of purposes including: improved determination of the

fine-structure constant; better determination of the Avogadro constant; critical testing of Einstein's energy-mass relation $E = mc^2$; placing limits on the mass of the electron neutrino; and providing improved values of the relative atomic masses of the proton, neutron, and deuteron. The measurements will be carried out using a new method—the simultaneous determination of the cyclotron frequency of two different ions—with the goal of achieving relative standard uncertainties smaller than 10^{-11}.

The aim of Staggs's project, "Measurement of the Polarization of the Cosmic Microwave Background," is to make the first observations of the expected 5 μK linear polarization of the cosmic microwave background (CMB). To accomplish this measurement, Staggs will develop a correlation microwave receiver of bandwidth 16 GHz operating at 90 GHz with front-end amplifiers cooled to 15 K and with noise temperatures of less than 50 K. Measurements of the spatial distribution of the polarization of the CMB will provide unprecedented, critical information about the fundamental cosmological parameters that describe the geometry of the universe, its large-scale energetics, and particle content.

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NIST HOSTS FIRST INTERNATIONAL SYMPOSIUM ON MEASUREMENT OF OPTICAL RADIATION HAZARDS

NIST sponsored the first International Symposium on Measurements of Optical Radiation Hazards, held at NIST Gaithersburg Sept. 1-3, 1998. The meeting was organized to cover the biological basis for health risk assessment, regulatory recommendations and guidelines, and measurement techniques necessary for hazard evaluations. The biological topics covered included skin erythema (sunburn), skin cancer, ultraviolet immune suppression, neuroendocrine and circadian regulation by light, cataract formation, and other ocular hazards. Industrial applications included lamp safety, welding, solar simulators for sunscreen testing, sunbeds, workplace safety, opthalmic instrumentation for eye surgery, and other medical instrumentation. It is believed to be the first conference ever held on the topic of measuring optical radiation hazards. Attending the conference were 139 researchers from the United States, Europe, Japan, Australia, and South Africa.

More than 50 invited talks were presented, along with many posters, contributed talks, and panel discussions. The three major sessions dealt with reviewing the photobiological basis of tissue damage and establishing human exposure guidelines; determining the adequacy of existing exposure guidelines; and state-of-the-art optical radiation hazard measurement techniques and future needs.

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NIST LOOKS AT DATA MINING FROM STATISTICAL PERSPECTIVE

In the interest of exploring statistical issues related to "data mining," several NIST statisticians recently attended the premier conference on data mining, called Knowledge Discovery and Data Mining-98, held in New York City. Two NIST scientists presented an invited tutorial, "New-Wave Nonparametric Regression Methods for KDD," on the statistical perspective of data mining.

Data mining is a rapidly expanding field driven by the demands of industry. Previously unheard of amounts of data are being collected in a wide range of commerce activities. Decision makers want to be able to mine these large data repositories for insightful and timely information. Data mining is a cross-disciplinary field that draws on many information technology areas such as high-performance databases, machine learning, and statistics.

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NEW SERVICE CHECKS TIME SOFTWARE'S Y2K COMPATIBILITY

NIST's Time and Frequency Division has established a service to assist users in testing how well their time-setting software will handle dates after Jan. 1, 2000. The year 2000 problem, or Y2K, refers to the failure of a computer program or system because the "00" year designation is mistaken for "1900."

The service sends the exact time to any computer that requests it, but transmits dates that are exactly 2 years in the future. For example, the message transmitted at 14:37:26 Coordinate Time Universal (known as UTC) on Nov. 1, 1998, had a time of 14:37:26 UTC on Nov. 1, 2000.

The service supports all common digital formats. The time of day will be correct and will be directly traceable to the NIST atomic clock. The service will run until the end of 1999. Users with time-setting software on their computers that receives digital time messages over the Internet can access this test facility by changing the address in the software to connect to "y2k-test.timefreq.bldrdoc.gov" (IP address 132.163.135.136). Users of NIST's Automated Computer Time Service modem dial-up service can test their systems by dialing (303) 554-7760.

Software modified to allow selecting the NIST Y2K test time-server is available free of charge on the World Wide Web at http://www.boulder.nist.gov/timefreq/service/nts.htm.

This facility is for testing only, and users should be careful about connecting operational systems to these servers. NIST will not be responsible for damage to systems that cannot properly handle dates in the year 2000 and beyond.

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THREE U.S. FIRMS RECOGNIZED FOR QUALITY AND BUSINESS EXCELLENCE

Named after a former Secretary of Commerce, the NIST administered Malcolm Baldridge National Quality Award (MBNQA) was established by Congress in 1987 to enhance the competitiveness of U.S. businesses by promoting quality awareness, recognizing quality and business achievements of U.S. companies, and publicizing these companies' successful performance strategies. The award is not given for specific products or services. Since 1988, 34 companies have received the Baldrige Award.

Two large manufacturers of aircraft and industrial gas turbines and a small manufacturer of identification and information labels were named the recipients of the 1998 MBNQA on Nov. 17, 1998. The companies are: Boeing Airlift and Tanker Programs, Long Beach, Calif.; Solar Turbines Inc., San Diego, Calif.; and Texas Nameplate Co. Inc., Dallas, Texas. Texas Nameplate is the smallest Baldrige recipient ever at 66 employees.

Baldrige Awards are given in manufacturing, service, small business, and, starting in 1999, education and health care. President Clinton and Commerce Secretary William Daley are expected to present the Baldrige Award to the 1998 recipient companies at a ceremony in Washington, D.C., early next year.

Further information on the 1998 Baldrige Award winners is available on the World Wide Web at http://www.nist.gov/public_affairs/news.htm, or by calling (301) 975-2762. Further information on the Baldrige National Quality Program is available on the WWW at http://www.quality.nist.gov, or by calling (301) 975-2036.

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SUMMARY OF SUMMIT ON U.S. STANDARDS STRATEGY PUBLISHED

A summary of the recent national "standards summit," which explored options for advancing U.S. technology interests in international standards, an area of growing importance to the nation's export performance, is now available from the NIST Office of Standards Services.

Sponsored by NIST and the American National Standards Institute, the Sept. 23, 1998, meeting attracted more than 300 representatives from U.S. companies, federal agencies, and standards developing organizations. Participants examined the feasibility and challenge of devising a national standards strategy, given the tremendous diversity within the U.S. voluntary standards system. More than 600 organizations and consortia develop standards in the United States.

The new report summarizes keynote addresses and three roundtable discussions involving a total of 20 speakers representing a variety of organizational perspectives. More complete proceedings of the summit will be published later this year.

To obtain a copy of Toward a National Standards Strategy, Conference Summary Report (NISTIR 6259), contact Judith Baker, NIST, 100 Bureau Drive, Stop 2100, Gaithersburg, MD 20899-2100, (301) 975-4000, judith.baker@nist.gov. The report also is available on the World Wide Web at http://ts.nist.gov/ts/htdocs/210/summary.htm.

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THREE NEW BIBLIOGRAPHIES OF ELECTRONICS-RELATED WORK AVAILABLE

Persons interested in the optoelectronics, electronics and electromagnetic research programs of the NIST Boulder, Colo., laboratories will want copies of bibliographies of technical work in these divisions dating back to 1970. The first, Metrology for Radio-Frequency Technology: A Bibliography of NIST Publications (NISTIR 5075), lists published research from the Radio Frequency Technology Division (formerly the Electromagnetic Fields Division) between January 1970 and July 1998. Subject areas discussed include antennas, dielectric measurements, electromagnetic interference, microwave metrology, noise, remote sensing, time domain and waveform metrology. The second volume is A Bibliography of Publications of the NIST Electromag-

netic Technology Division (NISTIR 5076). It lists the publications of this division from January 1970 through July 1998. Topics covered include cryoelectronic metrology, and superconductor and magnetic measurements. The third and final publication is Bibliography of the NIST Optoelectronics Division (NISTIR 5077). Subject areas covered include high-speed measurements, laser radiometry, fiber optic measurements, integrated optic measurements, optical fiber sensors, fiber and discrete components, dielectric materials and devices, and semiconductor materials and devices.

Copies of all three bibliographies are available at no charge from Sarabeth Harris, MC104, NIST, Boulder, CO 80303-3337, (303) 497-3237, sarabeth@boulder.nist.gov.
Media Contact: Fred McGehan (Boulder), (303) 497-3246; mcgehan@boulder.nist.gov.

A DECADE OF METROLOGY RESEARCH AT YOUR FINGERTIPS

Reprints of a decade of key papers by the Optical Frequency Measurement Group in NIST's Time and Frequency Division have been compiled and published as Precision Spectroscopy, Diode Lasers, and Optical Frequency Measurement (Technical Note 1504).

The papers describe work done over the past decade in the areas of diode lasers, frequency stabilization by optical and electronic techniques and by phase-locked loops, tunable lasers, optical synthesis, extended wavelength coverage, multiphoton interactions, and optical coherences. Several applications of diode lasers are described, such as an all-diode laser optical frequency reference using laser cooled and trapped atoms, detection of methane in air, high-sensitivity and high-accuracy spectroscopy, a 1 GHz delay line oscillator, a demonstration of laser oscillation without population inversion, and others.

TN 1504 is available from the Time and Frequency Division, MC 847, NIST, Boulder, CO 80303-3337. For more information, call (303) 497-3276 or go to http://www.bldrdoc.gov/ timefreq/ on the World Wide Web.
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TELEPRESENCE VIDEO AVAILABLE

NIST researchers and researchers of two other organizations in different locations are currently collaborating on the telepresence microscopy and microanalysis project, one of the projects under the National Advanced Manufacturing Testbed program. This project is developing techniques that allow the remote sharing and operation of microscopes or microprobes. The chemical microstructure of material specimens is critical to materials science and technology, semiconductor device development, quality measurements and process control, and failure analysis and evaluation. NIST microanalysis customers need quick access to advanced microscopy and microanalysis instrumentation and expertise, quality measurements of nanoscale dimensions and material chemistry properties, and a quick time response for analysis that is demanded by process control. A video called "The Telepresence Video" demonstrates the successful collaboration of researchers in three separate locations. It demonstrates how industry will be able to make more efficient use of expensive, scarce resources and critical personnel at industrial central laboratories by providing remote, instantaneous, around-the-clock access to critical production facilities; by providing "just-in-time" analysis; and by improving communications within the service analysis industry. In the near future, this information will also be available on CD.
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SMOKE ALARMS IN MANUFACTURED HOUSING STUDIED

Manufactured housing (also known as mobile homes) represents an important sector of the U.S. housing market providing as much as 30 % of "affordable housing." NIST researchers examined alternate strategies for smoke alarm placement that would reduce the incidence of nuisance alarms and provide an equal level of fire protection to that for other types of housing as embodied in the National Fire Alarm Code, NFPA 72.

The current HUD Standard requires smoke alarms to be installed outside sleeping areas. In many manufactured home floor plans, this requirement results in smoke alarms located close to cooking appliances and many nuisance alarms. There is evidence that high rates of nuisance alarms cause homeowners to disconnect the smoke alarms leaving them unprotected. Based on an audibility and location analysis, the researchers found no reason for the HUD Standard to differ in its requirements for smoke alarms, including number, location, power, and signaling configurations, from those applied to all other types of housing. The HUD Standard is being revised to incorporate requirements for manufactured housing consistent with those found in NFPA 72.
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NEW WWW SITE PROVIDES REMOTE, NIST-TRACEABLE TIME AND FREQUENCY CALIBRATION DATA USING GPS

NIST scientists have developed an online database of comparisons between the NIST time scale and the Global Positioning System (GPS) satellite signals. Calibration and standards laboratories that use GPS signals as a frequency reference can use the World Wide Web database to complete their chain of traceability to NIST. The database, accessible at http://gpsmonitor.timefreq.bldrdoc.gov/gpstrace.htm, is automatically updated each morning, and past data are archived. The archive allows users to retrieve past data and retroactively confirm the traceability of their measurements.

This service was developed in response to requests from calibration and standards laboratories and from GPS receiver manufacturers who develop products for the time and frequency marketplace. The new service complements the NIST Frequency Measurement and Analysis Service, another distributed calibration service allowing customers to calibrate time and frequency standards in their own laboratories by using a dedicated telephone connection to NIST to compare locally received GPS signals with NIST time and frequency standards.

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FREQUENCY SYNTHESIZERS FOR LASER-COOLED ATOMIC CLOCKS

Researchers at NIST have developed improved microwave frequency synthesizers to support new laser-cooled atomic clocks for both laboratory and advanced space applications. They are now developing a laser-cooled atomic fountain clock to replace NIST-7 as the nations primary frequency standard with significantly reduced uncertainty and are also working with NASA to develop a laser-cooled clock for use in Earth orbit, where the free-fall environment will permit lengthy observation of very slow atomic beams, reducing frequency uncertainties by an order of magnitude.

Critical to the dissemination of the signals from these new laser-cooled clocks are high performance microwave frequency synthesizers. These new synthesizers use simple and rugged digital technology, with some key components already space qualified. The phase stability, temperature coefficient, and frequency agility of the synthesizers should be more than adequate for every standard now under development and might well serve generations of standards beyond these. The new synthesizer technology also should be useful for standards for phase-noise and amplitude-noise measurements.

The key design advance is the use of digital technology and the removal of narrow-band filters, which typically produce temperature-stability and phase-stability problems. Measurements between a pair of these synthesizers indicate a fractional-frequency stability of less than 5×10^{-16} at 10 s averaging down to 1×10^{-18} at 1 d. The measured temperature coefficient is 0.12 ps/K. The new synthesizers are small (particularly important for space applications), and the circuitry is easier and less costly to assemble, since there are many fewer critical adjustments involved.

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1998 EDITION OF NIST SP 814 PUBLISHED

The 1998 edition of NIST Special Publication 814, Interpretation of the SI for the United States and Federal Government Metric Conversion Policy, has been published. Edited by Barry N. Taylor, the new edition of NIST SP 814 contains: (1) a diagram with accompanying text that shows graphically how the 21 derived units of the International System of Units (SI) that have special names and symbols are related to the seven SI base units; (2) the Department of Commerce, NIST, Federal Register notice of July 1998 that sets forth the current interpretation of the SI by the Department of Commerce for use in the United States; (3) the Metric Conversion Act of 1975, as amended in 1988, 1995, and 1996; (4) Executive Order 12770 issued by the President of the United States in July 1991 that provides Presidential authority and direction for the use of the metric system of measurement by federal departments and agencies in their programs; and (5) the Department of Commerce, Office of the Secretary, Federal Register notice of January 1991 that revised the Code of Federal Regulations to remove the voluntary aspects of the conversion to the metric system of measurement for federal agencies.

Single copies of SP 814 may be obtained from the NIST Metric Program, Building 820/Room 306, by calling (301) 975-3690, or by email at metric_prg@nist.gov.

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HIGH PRECISION CAPACITANCE CELL DEVELOPED FOR THIN FILM OUT-OF-PLANE EXPANSION

Two NIST researchers have developed a high precision capacitance cell for measuring thermal or humidity induced changes in the thickness of films between 5 μm and 1 cm thick. The relative expanded uncertainty in the thickness is 0.1×10^{-6} for isothermal measurements and 1×10^{-6} for thermal cycling under dry conditions (i.e., 0 % relative humidity). The accuracy of the cell has been verified using a $\langle 0001 \rangle$ Al_2O_3 single crystal 0.5 mm thick as the test standard. Thin film expansion data are needed by microelectronics industries and others to model and to predict the mechanical integrity of multilevel microelectronic chips subjected to temperature and humidity changes. No suitable technique was available for thin films in the micrometer thickness range. The process for submitting this cell design and the measurement protocol as a standard test method to the Institute for Interconnecting and Packaging Electronic Circuits has been initiated.

The cell design is unique in that it is based upon a three-terminal guarded electrode that isolates the sample from the measurement path so that the dielectric constant of the sample is not needed. For this reason, diverse materials such as polymers and ceramics can be measured using the current cell design. As an example, measurements were conducted on a 14 μm thick polymer film. Values determined for the thin polymer film agreed with those obtained by a combination of in-plane expansion measurements and volume dilatometry on larger samples to within the combined uncertainties. A future design modification will enable the expansion measurements of conductive materials such as metals.

Since the method requires the dielectric constant of air to be determined precisely, data reduction software and protocols were developed for humid conditions to estimate thickness values reliably. Theoretical calculations have been performed to estimate the minimum attainable uncertainty in these measurements. The ability of the data reduction software/protocol to provide accurate thickness values within the limits of these uncertainties has been demonstrated, and it is expected that this metrology will find a variety of other applications as an extremely sensitive displacement sensor.

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CHARGE MELTING IN COLOSSAL MAGNETORESISTIVE OXIDES

The magnetic properties of the lanthanum manganese oxide class of materials have attracted a great deal of interest recently because of the dramatic increase in conductivity these systems exhibit when the magnetic moments order ferromagnetically, either by lowering the temperature or applying a magnetic field. This large increase in the carrier mobility, which has been given the name "colossal magnetoresistivity" (CMR), is both of scientific and technological interest. In particular, it is anticipated that these materials may provide the next generation of read/write heads for the magnetic data storage industry, while the "half-metallic" behavior provides fully spin polarized electrons for use in magneto-electronics applications and for sensors in a variety of applications such as in the automotive industry.

The colossal magnetoresistivity is thought to originate from a magnetically driven insulator-metal transition, and a variety of explanations have been advanced to explain this phenomenon, such as the double-exchange mechanism, or Anderson localization due to antiferromagnetic interactions. However, a research collaboration involving scientists from NIST, a University, and a National Laboratory recently used neutron and x-ray scattering to discover that neither of these explanations is correct. Rather, above the ferromagnetic ordering temperature the researchers have found that a charge ordering takes place, which pins the charges in place and causes the insulating behavior. Associated with this charge ordering is a lattice distortion, which helps trap the charges. Then, as the ferromagnetic behavior begins to develop, the charge ordering melts and the system becomes metallic. Further work is now in progress to determine if the charge melting can be controlled by the application of electric fields, which would open up completely new avenues for applications.

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THE ELECTRODEPOSITION OF Al-Nb ALLOYS FROM CHLOROALUMINATE ELECTROLYTES

The susceptibility of conventional aluminum alloys to chloride-induced pitting corrosion is a major impediment to their general use. During the last several years, considerable progress has been made toward enhancing the corrosion resistance by alloying aluminum with a

variety of solute elements, including Cr, Ta, Mo, W, Ti, Nb, and Zr. For these alloying additions to be effective, they must typically be in solid solution at concentrations exceeding the equilibrium solubility; consequently, non-equilibrium alloying methods are required to obtain single phase material. Processing schemes such as melt spinning, sputter deposition, and ion implantation work but are too expensive. Electrodeposition is an excellent method and it is also lower in cost and readily scaled up to treat large pieces. Scientists at NIST are some of the first to research the electrodeposition of aluminum-refractory metal alloys and have examined the electrochemical behavior of niobium in an AlCl3:NaCl molten salt electrolyte at 190 °C and have determined that an electroactive niobium species can be produced by electrochemical dissolution. It was further found that aluminum-niobium alloys can be electrodeposited from this electrolyte following Nb dissolution. Alloys containing a Nb amount-of-substance fraction of up to 15 % have been electrodeposited. The structure and corrosion behavior of the Al-Nb films are being examined currently. They have potential as protective coatings for steel or more corrosion-susceptible aluminum alloys.
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FORENSIC IDENTIFICATION OF HUMAN HAIR

The distinguishing features of human hair were recently examined for purposes of human identification by NIST scientists. In this study, hairs from the same individuals were examined by two different techniques: on-line supercritical fluid extraction-gas chromatography/mass spectrometry (SFE-GC/MS) and mitochondrial DNA (mtDNA) sequencing. SFE-GC/MS determines the organic components extractable from the surface of the hair, including naturally deposited compounds from sebaceous and sweat glands, and artificially deposited species from conditioners, hair treatments, and environmental contaminants. The hypothesis is that a unique chromatographic spectrum, representing the various extracted components, would be generated for each individual. Mitochondrial DNA sequencing of the human hypervariable regions HV1 and HV2 has shown unique sequences from nonmaternally related individuals.

Results of the comparison of these two techniques on human hair samples indicate that SFE-GC/MS could distinguish between individuals and mtDNA sequence analysis was able to distinguish nonmaternally related individuals. DNA from maternally-related individuals can be used to verify the identifications. The combined use of these two complementary techniques is a promising approach especially since SFE-GC/MS is non-destructive and the same hair can be used for mtDNA analysis following SFE-GC/MS.

This work was presented at the Ninth International Symposium on Human Identification in October 1998.
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NIST STUDIES EMISSIONS FROM WILDFIRES IN THE FORESTS OF CANADA'S NORTHWEST TERRITORIES

For 3 weeks during June and July 1998, NIST scientists participated in the International Crown Fire Modeling Experiment (ICFME) near Great Slave Lake, Northwest Territories, Canada. Conducted by the Canadian Forestry Service, the ICFME is an ongoing experiment in the controlled burning of the boreal forest for the purpose of measuring the behavior of high-intensity crown fires and emissions from these fires. A total of 59 researchers and operational staff from Canada, Russia, Australia, France, and a host of U.S. government agencies, institutions, and companies converged on Ft. Providence, NWT, to participate in this comprehensive study.

With flames moving from treetop to treetop at up to 200 m s^{-1}, crown fires account for an overwhelming proportion of the area burned each year in Canada and, quite likely, the entire global boreal-forest belt that includes Siberia and Scandinavia. The ICFME is a vital and timely project for studying boreal wildfires because global climate change is expected to cause a sharp rise in fire activity of boreal regions. Unlike biomass burning in tropical regions, which is nearly all due to agricultural practices, more than 95 % of boreal wildfires are caused by lightning; therefore, the increase in natural boreal-fire activity due to climate change will not be curtailed simply by changing human cultural practices.

NISTs efforts focused on the sampling of combustion aerosols both at ground level and in the smoke plume via helicopter. These samples will provide a unique opportunity for NIST researchers to characterize these emissions chemically and isotopically, especially the carbonaceous component. Because black-carbon aerosols from combustion sources both scatter and absorb solar radiation, they remain a major source of uncertainty in models that predict climate change due to global warming. Since boreal wildfires are a natural combustion source, it is particularly important to distinguish the chemical/isotopic character of these emissions from those of anthropogenic sources such as fossil-fuel combustion and agricultural biomass burning. Through

this research, NIST will help the world community address critical metrological challenges in characterizing black carbon from combustion processes and in developing methodologies to distinguish natural boreal wildfire emissions from those emissions from the burning of tropical grasslands. Efforts will lead to improved identification and quantification of global biomass-burning sources as climate change inevitably proceeds into the 21st century.

By closely monitoring wildland fire potential from fuel moisture levels, fuel availability, expected rate of fire spread, and expected fire intensity, ICFME researchers ensured that burning took place under conditions that foster natural ignition and the development of full, raging crown fires. With optimal conditions occurring on July 4 and 5, 1998 successful crown fires consumed a total of 22 500 m^2 on each day. All objectives were met during the sampling mission, including samples to distinguish emissions during the flaming stage from those during the smoldering stage and samples to determine the extent that boreal wildfire emissions change as the smoke plume travels downwind.

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LATEST ADVANCE PAVES THE WAY FOR A QUANTUM-BASED DEFINITION OF MASS

Physicists at NIST have obtained a new value of the Planck constant, h, a constant that serves numerous roles in quantum mechanics. The new value for h of $6.62606891 \times 10^{-34}$ J · s has a relative uncertainty of 89×10^{-9} and instantly improves the accuracy of values for related fundamental constants, such as the electron mass, proton mass, elementary charge, and Avogadro constant. Further, the reduced uncertainty paves the way for a quantum-based definition of mass.

The measurement method, first proposed by a UK physicist in 1975, uses a moving-coil watt balance—an apparatus with a kilogram mass and a copper coil of wire in a magnetic field—that makes use of the Josephson and quantum Hall effects. First, the coil is allowed to move downward/upward, and its velocity and the voltage it generates is measured. Next, a current is sent through the coil, which creates an upward magnetic force that exactly balances the downward force of gravity on a standard of mass. From the data, in which factors such as the geometry of the setup cancel out, the value of h can be extracted. These results have been recently published (Edwin Williams, Richard Steiner, David Newell, and P. T. Olsen, Phys. Rev. Lett. **81**, 2404, 1998) and presented at a conference. At the same conference, the designs for the next generation of the experiment and details of the progress anticipated with these changes were also presented. The goal of the new version is to improve the uncertainty by an order of magnitude. This will allow the monitoring of the artifact kilogram and lead to a new quantum-based definition for the kilogram.

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TEAM FROM NIST IDENTIFIES DEFECT IN SET EXPERIMENT TO PROVIDE A FUNDAMENTAL REPRESENTATION OF CAPACITANCE

In an effort begun more than 3 years ago, a team of NIST scientists worked with researchers from a university to study the problem of charge offset noise in single-electron tunneling (SET) devices. In their most recent effort, the group made measurements of a two-level fluctuator (TLF) in a SET transistor and examined the dependence of switching rates on bias voltage, gate voltage, and temperature.

The results showed conclusively that the microscopic source (a structural defect) of the TLF is at a significantly higher effective temperature than the conduction electrons or the substrate. In particular, a detailed theoretical analysis, along with comparison with the data, shows that the defect is being heated by inelastic interactions with the electrons as they quantum-mechanically tunnel through the tunnel junction. The group will continue their effort to elucidate the mechanism(s) responsible for the noise and eliminate the problem. This is essential to achieve the ultimate resolution for the charged-capacitor experiment, which is to provide a fundamental representation of capacitance.

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NIST RESEARCHERS VALIDATE VIDEO QUALITY MEASUREMENT TOOLS FOR INTERNATIONAL TELECOMMUNICATIONS UNION

At the request of the International Telecommunications Union (ITU), NIST is participating in an effort to validate candidate models for an objective measurement of video quality. This activity is a natural follow-through to a previous assignment, specifically, to define testing procedures by which to validate the candidate models. For that task, NIST researchers worked as members of the Video Quality Experts Group (VQEG), which is affiliated with the ITU. Earlier this year, an international meeting of the Video Quality Experts Group (VQEG) was held at the NIST facility in Gaithersburg to finalize

these testing procedures. The results of the testing program will support VQEGs recommendation to the ITU of a standard method for an objective video quality measurement.

The VQEGs Independent Laboratory Selection Committee, of which NIST is a member, selected 20 video test sequences, 10 each for the United States (NTSC-525 lines/60 fps) and the European (PAL-625 lines/50 fps) video standard formats. In addition, the VQEG finalized the definitions of the hypothetical reference circuits (compression processing conditions) under which the video sequences are processed to create the test material that will be measured by each of the candidate metrics. The statistical methods by which the test results are to be evaluated and the procedures for the conduct of both the subjective and objective quality measurements also were defined by the group.

In the current effort, 10 proposed objective measurement models are being validated with respect to their ability to predict subjective judgements of video quality. Both subjective testing and verification of objective measurements will be conducted by independent laboratories. As an independent, objective, testing laboratory, NIST will apply three of the proposed measurement algorithms to a subset of the video test data. Then, at the request of the VQEG co-chairs, NIST will perform the statistical analysis of all the data resulting from the test program. The group expects to complete the testing by the end of calendar year 1998 and to issue a report of the results and recommendations by March 1999.

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IMPROVED TECHNIQUE FOR ASSESSING MEASUREMENT SYSTEMS FOR HIGH VOLTAGE EQUIPMENT TESTING WILL REDUCE ERRORS INTRODUCED BY TESTS AND IMPROVE THEIR ACCURACY

High reliability of electric power equipment such as power transformers is assured by testing it with high voltage (hv) pulses prior to placing the equipment into service. The accuracy requirements for hv pulse measurements used in this testing is specified by national or international test standards, which have become stricter in recent years. To ensure that the measurement system errors do not exceed the requirements, signal processing techniques such as numerical convolution have been prescribed by IEEE Standard 4-1995 on hv testing. A new technique for effectively performing the deconvolution of measured high voltage impulse waveforms has been developed by NIST researchers that has much less sensitivity to the random noise inherent in hv pulse measurements than direct deconvolution methods. Using the latter, small random errors in the measured waveforms can result in large errors in the deconvolved waveforms.

The key to the new technique is the use of a numerical model, based upon the impedance parameters of the test circuit, for the hv pulse that appears at the input to the measuring system. A forward convolution of this numerical model with the measured response of the hv measuring system is then used to calculate the output waveform. Subsequently, the model is iteratively adjusted to find the best fit between the calculated waveform and a measured hv pulse waveform using the Levenberg-Marquardt nonlinear least squares fitting algorithm. When found in this way, the optimal model waveform is effectively the deconvolution of the impulse waveform recorded by the measurement system. By comparing the deconvolved waveform with the recorded one, it is possible to estimate the amplitude errors and waveshape distortion introduced by the measurement system and then determine whether the measurement system errors meet the requirements of the standards.

To further substantiate their results, the researchers tested the model-based deconvolution approach with simulated waveforms having added random noise. These tests demonstrated that the errors associated with the amplitude and time parameters were well within the requirements of the standards, even with waveforms having noise levels of 5 % of the peak amplitude. When this technique is transferred to industry, it will yield a double benefit: it will help to correct those errors introduced by hv measurement systems and improve the measurements made during the high-voltage testing of electric power equipment.

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OPTICAL DISC BIREFRINGENCE ROUND ROBIN DEMONSTRATES NEED FOR INDUSTRY-WIDE MEASUREMENT STANDARDS

Currently, optical discs (CDs) are the most popular distribution format for the music and software industries, and the new higher density formats (DVDs) are poised to replace prerecorded videotape. However, there are still significant problems to solve. Over the last decade, pressure to reduce the manufacturing costs of replicated optical discs has led to significant decreases in manufacturing time. The shorter stamping times, in turn, have greatly increased the need for dependable process controls and accurate disc-testing equipment to monitor the manufacturing process and ensure disc quality. To create a realistic picture of the challenges

facing disc manufacturers, a NIST scientist worked with replicators and test equipment manufacturers through the Optical Disc Manufacturing Association to coordinate a round robin study to quantify measurement variations within the industry.

Birefringence, or retardance, is an optical property influenced by the replication process that can affect significantly the light beam used to read the disc. Birefringence makes the propagation of light dependent on the incident polarization state and can redirect the beam and enlarge the focused spot so that data readout from the optical disc is degraded. If not held within acceptable levels, birefringence can affect disc playability. Retardance measurements of 20 discs were made by seven round robin participants using a variety of commercial instruments; NIST also conducted measurements on a sample of the discs using an apparatus developed in-house for this purpose. Considerable variation was observed, even between repeated measurements by the same commercial instrument. These variations were large enough to result in the rejection of discs that actually met established specifications. Initially, a large part of this variation was attributed to real changes in the measured retardance, but additional work at NIST indicated that less than half of the variation could be reasonably attributed to changes in disc temperature, measurement angle, or measurement position. For example, it is difficult to control temperature in a manufacturing environment, and the range of temperatures over which discs were measured was considered a major source of round robin variation. However, NIST measurements showed that the rate of temperature change is much more important than the equilibrium measurement temperature; since round robin measurements were made at thermal equilibrium, temperature was a small source of measurement variation. As a result of these findings, NIST researchers have developed several methods for accurately measuring disc retardance and are working with test equipment manufacturers to develop improved calibration artifacts.

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ALTERNATIVE METHOD FOR DETERMINING FLAMMABILITY OF ALTERNATIVE REFRIGERANTS DEVELOPED BY NIST RESEARCHERS

Researchers at NIST have developed a new method for identifying the flammability of refrigerants being considered as substitutes to nonflammable, but ozone-depleting, CFCs. The current approach used by industry for assigning the flammable limits, ASTM E 681, requires the subjective judgment of the test operator on whether or not a flame emanating from a spark spreads beyond a certain dimension within a closed vessel. Operator variability and a sensitivity of the results to the ignition process, mixture humidity, and temperature are a concern of the Air-Conditioning and Refrigeration Institute, which motivated them and the Department of Energy to support NIST research to better understand the spread of flame through refrigerant air mixtures and to demonstrate an alternative means to measure flammability not subject to the same deficiencies.

By decreasing the fuel/air ratio of an established premixed, counter-flow flame (while maintaining the flow velocity constant), an unambiguous extinction point can be determined. The extinction concentration of refrigerant can be measured for decreasing flow velocities, so that the concentration at zero flow can be determined by extrapolation. Using this method, a distinct flammability limit can be determined even for weak fuels like many of the hydrofluorcarbons under consideration for CFC refrigerant replacements. The theory of operation and a description of the experimental facility designed specifically for the new generation of refrigerants are included in a final report, and published as NISTIR 6229, Flammability Limit as a Fundamental Refrigerant Property. The results for various refrigerant mixtures are compared to data taken in the ASTM E 681 apparatus, the uncertainties of the measurements are quantified, and recommendations for further activities are made that can lead to a science-based methodology for assessing the risk of fire from refrigeration machine working fluids.

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OOF SYSTEM FOR SIMULATING MEASUREMENTS OF MATERIAL MICROSTRUCTURE RELEASED

The behavior of a material on the macroscopic scale depends to a large extent on its microstructure, the complex ensemble of polycrystalline grains, second phases, cracks, pores, and other features existing on length scales, which are large compared to atomic sizes. In September, NIST released version 1.0 of OOF, a finite-element program for analyzing material microstructures and conducting simulated physical property measurements on those microstructures. OOF allows materials scientists to determine the influence of microstructure on a material's macroscopic properties through an easy-to-use graphical interface.

The OOF user begins with a realistic microstructural geometry by loading a two-dimensional image of a real or simulated material into the program. Features in the

image (e.g., grains, pores, and grain boundaries) are identified and assigned local material properties (e.g., crystalline symmetry and orientation, elastic constants, or thermal expansion coefficients). By applying stresses, strains, or temperature changes, the user can measure the effective macroscopic material behavior or can examine internal stress, strain, and energy density distributions. By modifying a microscopic material property, the user can find the effect of that property on the macroscopic behavior, or by modifying the microstructure, the effect of geometry on a particular material can be determined. OOF currently handles only thermoelasticity, but extensions to other material properties are planned.

For more information, visit the OOF web site at http://www.ctcms.nist.gov/~wcraig/oof.

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NIST SIGNS MUTUAL RECOGNITION ARRANGEMENT TO BENEFIT U.S. MANUFACTURERS OF IT SECURITY TECHNOLOGY

U.S. manufacturers will be able to sell their evaluated, security-enhanced IT products to Canada, France, Germany, and the United Kingdom. The Mutual Recognition Arrangement signed in October 1998 allows these sales without duplicate, costly evaluations in each of these importing nations. As part of the National Information Assurance Partnership (NIAP), NIST is developing a Common Criteria Evaluation and Validation Scheme for Information Technology (IT) Security. The scheme will provide an organizational structure and framework for private sector testing laboratories to conduct security evaluations of IT products using the Common Criteria, an emerging ISO standard (FCD 15408). Results from the IT security evaluations will be validated by NIAP. Upon successful completion of the security evaluations and follow-on validations, NIAP will issue Common Criteria certificates that will be recognized under the Arrangement.

The development of the Common Criteria Scheme involves many important groups from both the public and private sectors. To ensure a fair and open process, NIST conducted a public workshop in September 1998 that brought together more than 200 participants from government and industry representing consumers of IT security products, major producers of IT products, and over a dozen potential IT security testing laboratories. In addition to the U.S. participants, the importance of the global economy was illustrated by the attendance of government and industry representatives from six foreign countries.

The material from the workshop has been provided to the public by NIST via the NIAP Web site (http://niap. nist.gov/schemeCC.html). This information is being used by NIST in the formulation of its security testing laboratory accreditation criteria being developed in cooperation with the National Voluntary Laboratory Accreditation Program.

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CIRMS HOLDS SEVENTH ANNUAL MEETING AT NIST

NIST hosted the seventh annual meeting of the Council on Ionizing Radiation Measurements and Standards (CIRMS) in Gaithersburg in October 1998. CIRMS represents thousands of users of ionizing radiation and radioactive sources engaged in industrial radiation processing and sterilization, medical radiation diagnostics and therapy, nuclear power generation, worker radiation protection, and environmental measurement programs. CIRMS provides a forum for discussing ionizing radiation issues; identifying, defining and prioritizing needed work; disseminating information on standards; and organizing workshops and meetings to advance ionizing radiation technology.

More than 100 participants from 25 corporations, 14 federal and state agencies, and seven national laboratories attended the meeting that highlighted contributions of Federal laboratories in ionizing radiation and radioactivity measurements. Papers and posters addressed the specialties of the four CIRMS subcommittees: medical applications, occupational radiation protection, public and environmental radiation protection, and industrial applications and materials effects. Featured at this years meeting were international experts who provided information on closely related work in their laboratories.

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WORKSHOP ON NEW DEVELOPMENTS IN RADIATION PROTECTION DOSIMETRY

NIST hosted the Workshop on New Developments in Radiation Protection Dosimetry in September 1998, at NIST Gaithersburg. More than 40 U.S. and European researchers, personnel dosimetry processors, dosimetry equipment manufacturers, and regulatory officials participated. Participants addressed the measurements and standards the U.S. dosimetry processing industry requires to accurately monitor personnel exposure and to remain competitive internationally. The workshop was sponsored by the Council on Ionizing Radiation Measurements and Standards, an industry-academic-

NIST advisory group that helps NIST determine customer measurement needs and priorities.

A major topic of the workshop was discussion of revision of radiation protection dosimetry standards. Radiation protection dosimetry is the determination of low level ionizing radiation dose received by workers. In the United States, more than 2 million radiation workers are monitored by the personnel dosimetry processing industry. The Nuclear Regulatory Commission requires these processors to be accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) administered by NIST. NVLAP conducts testing of processors according to the American National Standards Institute (ANSI) Standard N13.11-1993, Personnel Dosimetry Performance Criteria for Testing, currently being revised by a working group of industrial processors, military, and primary and secondary standards laboratory personnel.

Other Workshop topics included discussion of the new International Organization for Standardization (ISO) draft standard for personnel dosimetry performance testing; discussion of new ISO reference radiation standards and their US implementation; and progress in implementing ISO standards for photon and beta particle reference radiation fields at NIST and other national metrology institutes.

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OIML RECOMMENDATION ON EVIDENTIAL BREATH ANALYZERS DISCUSSED

The recently approved OIML Recommendation 126 "Evidential Breath Analyzers" was discussed at a meeting of the International Association for Chemical Testing (IACT) held in Las Vegas, Nev. in April 1998. A NIST scientist who is the U.S. representative to the International Organization of Legal Metrology (OIML), participated in a panel discussion at that meeting on the implication of this recommendation for national programs related to the official legal use of evidential breath analyzers.

Currently, each state is responsible for pattern (type) approval and initial and periodic verification of these instruments. The Department of Transportation carries out type approvals and lists manufacturers instruments that conform to federal performance requirements established for the instruments. The performance requirements and the method of testing for conformance are based on work done at NIST in the 1970s. An effort is now being considered to harmonize the performance requirements of these instruments among the states based on the requirements of OIML R 126.

In addition, the Department of Transportation plans to upgrade its testing laboratory to be able to evaluate instruments according to the OIML requirements and, hence, then to be able to issue OIML Certificates to manufacturers for models of instruments that successfully meet those requirements. Such certificates should assist U.S. manufacturers, who now have a dominant position, in marketing their instruments abroad. In addition, harmonization of performance requirements for these instruments among the states should provide more confidence in their implementation in highway safety programs intended to minimize the problems associated with operating motor vehicles under the influence of alcohol.

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MEETING ON MUTUAL AGREEMENTS ON OIML PATTERN EVALUATIONS

NIST hosted an international meeting at at its Gaithersburg site in April 1998 to address establishing a Mutual Agreement of Utilization of Pattern Approval Certificates and Associated Test Reports in National Pattern Approval Programs. Representatives from Australia, Canada, China, France, Germany, Japan, Netherlands, United Kingdom, and the United States attended.

The discussions at the meeting focused on principles of establishing mutual agreements on acceptance and utilization of pattern approval certificates and associated test reports in national pattern approval programs. In particular, the International Organization of Legal Metrology (OIML) Recommendation 60 "Load Cells" and Recommendation 76 "Nonautomatic Weighing Instruments" within the OIML Certificate System were considered since these devices and instruments represent those for which much experience in testing already has been obtained within the international community. However, the principles developed are expected to apply to other instrument categories. A first draft proposal on Mutual Agreements on OIML Pattern Evaluations was presented by the chair at the meeting, and, based on the discussions, a second draft was prepared and distributed to participants after the meeting for comment.

This proposal will be presented for consideration by the International Committee of Legal Metrology for adoption as an OIML program at its next meeting and should contribute to OIML's efforts in establishing global confidence in and harmonization of legal metrology practices and activities among its members.

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NASA, IN COLLABORATION WITH NIST, WILL PROVIDE HIGH-ACCURACY DIMENSIONAL MEASUREMENTS OF LARGE OPTICS

High-accuracy dimensional measurements of large optics, i.e., dimensions from about 0.5 m up to about 15 m in diameter, are needed by U.S. industry and government agencies. Although NIST has no current intent to develop in-house measurement facilities, it has agreed to collaborate with NASA Marshall Space Flight Center (MSFC) to meet this need. These services aim to support the U.S. manufacture and use of large-diameter optics, reduce the cost of production of such optics, and ensure attainment of the precision in optics necessary for the success of programs such as NASA's development of advanced observatories. MSFC develops and maintains the primary NASA large-diameter-optics fabrication and metrology capability. The collaboration will enable MSFC to become the NASA primary standards laboratory for dimensional measurement of large-diameter optics and a national resource for traceable, high-accuracy dimensional measurements of such optics that will be accessible by U.S. industry and government. T. Vorburger and C. Evans, both NIST scientists, will serve as primary technical contacts with NASA MSFC. The primary technical contact for NASA is R. Burdine.

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GLOW DISCHARGE OPTICAL EMISSION SPECTROMETRY

NIST has signed a Cooperative Research and Development Agreement (CRADA) with a private company entitled "Development of Glow Discharge Optical Emission Spectrometry (GD-OES)." The CRADA is intended to broaden the application and usefulness of GD-OES, both within NIST and for U.S. industry, by improving the quantitative capabilities of this technique. One aspect of the NIST research is the investigation of the glow discharge sputtering source for its usefulness in determination of nonmetal species (e.g., carbon, silicon, phosphorus, sulfur) in materials. NIST is specifically exploring calibration strategies for accurate measurement. The goal is to transfer these measurement capabilities to the commercial instrument user community and to benchmark these capabilities in the traditional NIST manner—through the analysis and certification of Standard Reference Materials.

NIST's general research goal is to improve the reliability of glow discharge optical emission spectrometry for chemical analysis and the state-of-the-practice for this technique. Last year, NIST identified a more efficient and accurate method of transferring the emission from the glow discharge source to the optical spectrometer. A two-lens optical transfer system was successful in correcting 1 % to 2 % errors observed in typical samples. Though relatively small, this level of error is of concern in quantitative GD-OES analyses. In addition, NIST recognizes the need for developing quantitative compositional depth-profiling capabilities of GD-OES because of the broad technological impact of coatings on materials and the need to benchmark accurately their thickness and elemental composition.

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SYMPOSIUM ON OPTICAL FIBER MEASUREMENTS

NIST hosted the 10th Symposium on Optical Fiber Measurements in September 1998 at its Boulder Labora-tories. This series of meetings, started in 1980, has become one of the principal forums for reporting recent research results on the characterization of optical fiber and related components. During this years two-and-a-half day symposium, 175 scientists from 19 countries heard 44 papers covering a wide range of topics. Of great interest were measurements of polarization mode dispersion, length dependence of chromatic dispersion, and bandwidth of multimode fiber. This last topic provided an interesting echo of the first symposium, when multimode fiber was the principal type of fiber in use. Subsequently, multimode fibers were relegated to use in local area networks, but now those networks are being upgraded to gigabit data rates, and the information carrying capacity of such fibers is again an issue. While the supply lasts, the Technical Digest of the Symposium may be obtained from the Optoelectronics Division at (303) 497-5342 or e-mail: optoelectronics@boulder.nist.gov.

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NIST BRINGS TOGETHER STAKEHOLDERS OF PORTABLE ELECTRONIC BOOKS

NIST and the Video Electronics Standards Association (VESA) co-sponsored the worlds first workshop on portable electronic books. Held at NIST in October 1998, "Electronic Book '98: Turning a New Page in Knowledge Management," attracted more than 400 people. The workshop brought together technology stakeholders for electronic books, including manufacturers, display makers, software developers, content

providers and end users, to discuss first- and next-generation electronic books. It also provided a forum to identify standards and interoperability issues for this emerging technology. Highlights of the workshop included the first meeting of the Open Electronic Book Standards Committee, the major goal of which is to develop voluntary standards for electronic content and interoperability among the different electronic book platforms. NIST presented its own electronic book testbed project, the NIST CD-Book. An interesting aspect of the project is that high school and college students performed 90 % of the required R&D.
CONTACT: Victor McCrary, (301) 975-4321; victor.mcrary@nist.gov.

NIST UPDATES DATA FORMAT FOR EXCHANGE OF FINGERPRINT INFORMATION

To meet the needs of the law enforcement community, NIST convened a Fingerprint Data Interchange Workshop in September 1998 to reevaluate the 1993 ANSI standard, Data Format for the Interchange of Fingerprint Information. Workshop participants identified existing problems and recommended improvements to the standard. Suggestions adopted during the meeting clarified existing information fields and created additional tagged fields to meet the requirements of law enforcement. A new tagged field record structure was created for the interchange of palm print information. Two additional tagged field records were created for exchanging high-resolution known and latent fingerprint images. These record types require a minimum scanning resolution of 20 pixels per millimeter but allow for the use of higher scanning resolutions in anticipation of future product developments.
CONTACT: Michael McCabe, (301) 975-2932; michael.mccabe@nist.gov.

NIST SUPPORTS CONSORTIUM IN DEVELOPMENT OF INTERFACE STANDARDS FOR BASIC LINEAR ALGEBRA SUBPROGRAMS (BLAS)

NIST is on of the participants in the BLAS Technical Forum, a consortium of industrial, academic, and government partners who are developing interface standards for Basic Linear Algebra Subprograms (BLAS). The major aim of these standards is to enable linear algebra libraries to inter-operate efficiently and easily. Obtaining high performance for core linear algebra operations is important since these form the performance-critical portion of many numeric applications. The BLAS for dense matrix operations in Fortran, which were developed by researchers in the 1980s, have been adopted widely by commercial software and hardware manufacturers. Subgroups within the forum are addressing extensions into new areas such as sparse matrices and extended precision arithmetic, as well as alternate language bindings for the legacy BLAS.

Further information on the BLAS Technical Forum can be found at http://www.netlib.org/cgi-bin/checkout/blasr/blast.pl.
CONTACT: Roldan Pozo, (301) 975-4317; roldan.pozo@nist.gov.

Standard Reference Materials

SECOND SRM FOR OPTICAL FIBER METROLOGY AVAILABLE

Scientists at NIST have developed a second Standard Reference Material (SRM) to assist the optical fiber communications industry with wavelength division multiplexed (WDM) optical fiber communication systems.

In a WDM system, many wavelength channels are sent down the same fiber, thereby increasing the bandwidth of the system by the number of channels. If one channel's wavelength were to shift, cross-talk could occur between it and a neighboring channel. Wavelength references are needed in the 1500 nm region to calibrate the optical instruments used to evaluate system components and measure the channels' wavelengths.

NIST has produced two SRMs with optical fiber coupled cells containing gases, which have accurately measured absorption lines in the 1500 nm region. The first, SRM 2517, is based on the fundamental absorptions of light by acetylene. The newest, SRM 2519, utilizes an absorption cell containing a small quantity of hydrogen cyanide and is intended for use in calibrating the wavelength scale of wavelength measuring equipment in the spectral region from 1528 nm to 1563 nm.

To obtain more information on SRMs 2517 and 2519, contact Sarah Gilbert, MS 815.03, NIST, Boulder, CO 80303-3337, (303) 497-3120, sgilbert@boulder.nist.gov. To order, contact the SRM Program, NIST, 100 Bureau Drive, Stop 2321, Gaithersburg, MD 20899-2321, (301) 975-6776, fax: (301) 948-3730, srminfo@nist.gov.
Media Contact: Fred McGehan (Boulder), (303) 497-3246; mcgehan@boulder.nist.gov.

NIST DEVELOPS NEW SRM FOR WAVELENGTH CALIBRATION OF OPTICAL FIBER COMMUNICATION SYSTEMS

Optical fiber communication systems are becoming more complex as operators try to push ever more information down the same fibers. New systems are being adopted which expand capacity by using many different wavelengths of light; these wavelength division multiplexing (WDM) systems operate in the 1500 nm near infrared wavelength region. NIST scientists have developed a new wavelength reference now available as Standard Reference Material (SRM) 2519. The SRM enables accurate wavelength calibration of equipment and characterization of the wavelength dependence of the optical components used in WDM systems.

The SRM is an optical fiber coupled absorption cell containing a small quantity of hydrogen cyanide gas. A user-supplied light source can be coupled into and out of the units via optical fiber connectors. The gas molecules have distinctive absorption features in the 1500 nm region due to their quantized vibrational and rotational motion. Fundamental molecular absorption lines provide references that are very stable under changing environmental conditions and have well-understood physical behavior. Hydrogen cyanide has more than 50 accurately measured lines in the 1530 nm to 1565 nm region. NIST has measured the line centers and pressure-induced shifts of 21 lines and certifies their wavelengths with an expanded uncertainty (coverage factor $k = 2$) of 0.0006 nm. The remaining lines in the band are certified with an expanded uncertainty of 0.003 nm.

SRM 2519 is part of a series of wavelength references for optical fiber communications. SRM 2517, which was introduced in 1997, is based on the absorption of light by acetylene. Current NIST research is focused on providing higher resolution wavelength references and covering other wavelength regions where WDM systems are being developed.

CONTACT: Sarah Gilbert, (303) 497-3120; gilbert@boulder.nist.gov.

WORLDS FIRST COPLANAR WAVEGUIDE CALIBRATION SETS NOW AVAILABLE AS NIST REFERENCE MATERIALS

Coplanar waveguide calibration sets fabricated at NIST have become NIST's newest high-frequency Reference Material (RM), the NIST RM 8130. These calibration sets give manufacturers a means of verifying the integrity of their microwave wafer-probe measurement stations using NIST-developed methods for measuring instrument drift and precharacterized NIST artifacts. This is the first attempt by any standards laboratory to use standard artifacts to support microwave on-wafer measurements. The RMs, which contain microwave circuitry characterized at NIST, can be used to measure the drift of microwave on-wafer probing stations and to verify that the instrumentation is capable of repeating NIST measurements. It is also possible to test the integrity of the test instrumentation and setup using the RMs. For example, the test procedure identifies unsound connections and other common instrument problems.

NIST developed the verification sets with the help of the NIST Monolithic Microwave Integrated Circuit (MMIC) Industrial Consortium. Each RM contains a thru-reflect-line (TRL) calibration set and 12 test structures characterized at NIST. Additional information on this new reference material is available on NIST's High-Speed Microelectronics Project web site. The
address is http://www.boulder.nist.gov/micro/.

CONTACT: Bob Judish, (303) 497-3380; judish@boulder.nist.gov.

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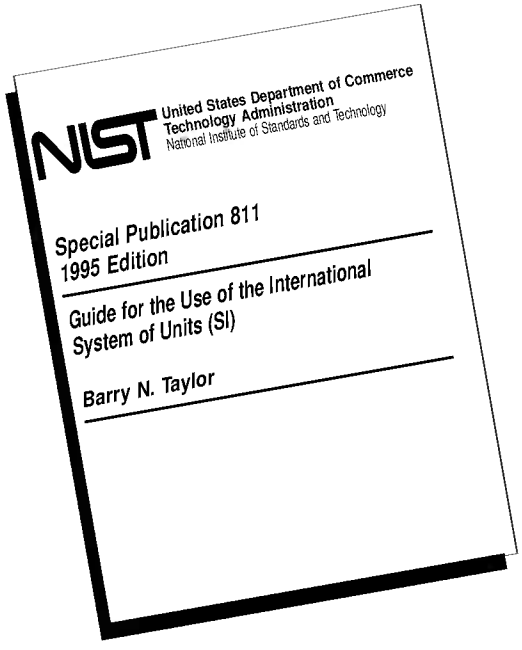
The International System of Units (SI)

The Modern Metric System



Uncertain about the International System of Units (universally abbreviated SI), the modern metric system used throughout the world? Do you need to know the proper way to express the results of measurements and the values of quantities in units of the SI? Do you need to know the NIST policy on the use of the SI? Then you need the 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*.

The 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*, by Barry N. Taylor, is now available.

The 1995 edition of SP 811 corrects a number of misprints in the 1991 edition, incorporates a significant amount of additional material intended to answer frequently asked questions concerning the SI and SI usage, and updates the bibliography. The added material includes a check list for reviewing the consistency of written documents with the SI. Some changes in format have also been made in an attempt to improve the ease of use of SP 811.

The topics covered by SP 811 include:

- NIST policy on the use of the SI in NIST publications.
- Classes of SI units, those SI derived units that have special names and symbols, and the SI prefixes that are used to form decimal multiples and submultiples of SI units.
- Those units outside the SI that may be used with the SI and those that may not.
- Rules and style conventions for printing and using quantity symbols, unit symbols, and prefix symbols, and for spelling unit names.
- Rules and style conventions for expressing the results of measurements and the values of quantities.
- Definitions of the SI base units.
- Conversion factors for converting values of quantities expressed in units that are mainly unacceptable for use with the SI to values expressed mainly in units of the SI.
- Rounding numbers and rounding converted numerical values of quantities.

Single copies of the 84-page SP 811 may be obtained from the NIST Calibration Program, Building 820, Room 232, Gaithersburg, MD 20899-0001, telephone: 301-975-2002, fax: 301-948-3825.

NIST Technical Publications

Periodical

Journal of Research of the National Institute of Standards and Technology—Reports NIST research and development in those disciplines of the physical and engineering sciences in which the Institute is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Institute's technical and scientific programs. Issued six times a year.

Nonperiodicals

Monographs—Major contributions to the technical literature on various subjects related to the Institute's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NIST, NIST annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NIST under the authority of the National Standard Data Act (Public Law 90-396). NOTE: The Journal of Physical and Chemical Reference Data (JPCRD) is published bimonthly for NIST by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements are available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

Building Science Series—Disseminates technical information developed at the Institute on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NIST under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NIST administers this program in support of the efforts of private-sector standardizing organizations.

Order the **following** *NIST publications—FIPS and NISTIRs—from the National Technical Information Service, Springfield, VA 22161.*

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NIST pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NIST Interagency Reports (NISTIR)—A special series of interim or final reports on work performed by NIST for outside sponsors (both government and nongovernment). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Service, Springfield, VA 22161, in paper copy or microfiche form.

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